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ABSTRACT

This booklet discusses the many psychological factors involved in the learning process. The author offers suggestions on the following problems: (1) the technology of teaching and the psychology of learning; (2) programs and rewards; (3) motivation; (4) learning and behavior control; (5) the role and responsibility of the teacher; (6) standards of performance; (7) the importance of models; (8) the psychology of educating; (9) achievement levels; (10) time factors in learning; (11) the role of the learner; (12) learning strategies; (13) remembering; (14) ways of coping with forgetting; and (15) the importance of differentiating in the learning process. (JD)

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and many more learners. Our present psychology of learning is not of much help to parents (the first teachers) or to teachers in the schools. We must recognize, however, that even with a complete psychology of learning we might be unable to improve on teaching if education continues to be a mass enterprise, supported by taxes from reluctant citizens, while large and impersonal social forces dominate the operation.

The Technology of Teaching—Programs and Rewards

Another truth must be faced immediately: The technology of teaching can be greatly altered, perhaps bettered, without any improvement in our understanding of the learning process. Thus, B.F. Skinner has been able to produce a book, *The Technology of Teaching*, which describes how individual students can greatly improve their skills and scores on tests without worrying about the psychology of learning. The simple fact that we can change someone's behavior, making him more knowledgeable or skillful, does not mean that we know how the person learned or what learning is.

Skinner's *technique* is to prepare a *program* (a detailed syllabus of a course, in question form, wherein each question builds on the answer to the question before it). Such a program requires that the *teacher know* what he wants the learner to say or do when he finishes the program. If the teacher's desire is to have someone go through the steps of solving a problem in square root, a program can be designed to accomplish this. *But*—and this is a most important *but*—the teacher must know exactly what he wants. Note that we are not concerned with what the student wants. In some cases the student may want the same thing as his teacher, but the student's goals are not considered in the design of the program.

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Some Practical Laws of Learning

By B.R. Bugelski

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The Technology of Teaching and the Psychology of Learning

It is obvious that there are more teachers in this world than there are psychologists, especially psychologists concerned with learning. Just as obviously, teachers were around and some learning was achieved before the first psychologist took any interest in the subject (about 1880). We might point out, too, that many babies were born before the first obstetrician hung out his* shingle. Thus teachers can get along without the advice of psychologists just as mothers can deliver without the attention of obstetricians. Nevertheless, both mothers and teachers need a little help in special cases.

Teaching is a technology and the psychology of learning is a science. Teachers are to psychologists as engineers are to physicists. Physicists do not build bridges; engineers do. Long before engineers arrived on the scene, bridges were built by barbarians who didn't want to get wet. But barbarians couldn't build the Golden Gate bridge—not even the Brooklyn bridge. Physics as a science had to be developed first. In the same manner, if humanity's full potential for learning is to be realized, psychologists will need to develop their science and teachers will have to make use of it. In learning, we are less than a century beyond the barbarians.

When we get a psychology of learning that is far better developed than the one we have, we may also be able to teach more and faster—

*For clarity and economy, we use the masculine form of pronouns throughout this fastback when no specific gender is implied. While we recognize the trend away from this practice, we see no graceful alternative. We hope the reader will impute no sexist motives; certainly no sexism is intended. —*The Editors*

The Problem of Motivation

When Skinner worked with rats or pigeons, *he* decided what he wanted the animals to do and arranged conditions in such a way that the animals did it. Skinner analyzed every step in a particular chain of behaviors that led to the desired activity. He knew the location (or time) of each link in the chain and started with the first link once it was identified. With animals, usually the first link is to make them hungry (it keeps them from getting side-tracked, among other things). The second link would then be to make the first move or otherwise get into position for the next link. To do this, Skinner found it useful to reward (feed) the animals at each step.*

In the case of humans we have the same problem that is solved in hungry animals by food: namely, getting the prospective learner into a learning situation. No one is going to learn anything if he is otherwise busy and has his eyes and ears closed to the teacher. Skinner solved this problem with children by providing them with naturally attractive toys. He called them "teaching machines," because children did learn with them. But they were only devices to capture the attention of children, made attractive by things like buzzers, bells, flashing lights, and candy or other desired "rewards." With adults one does not need such devices, since they can be told to work at the program with the prospect of some benefit. If the adult wants the alleged benefit, the motivation problem is solved.

*Actually, the steps in the animal situation are worked out backwards, so that the animals "learn" the last step first and the first step last; but we will ignore this procedural arrangement.

All we have said so far is that you cannot learn what is in a book until you open it. That is the first and minimal requirement. If we can get an adult to open a book or listen to a lesson, that person is in position to begin learning. Skinner believes that adults and children learn because they are rewarded—the children by candy and the adults by knowledge or by getting the right answers and knowing they are right. We speak of such rewards or motivation as intrinsic. Whether the rewards have anything to do with learning remains to be seen. As motivators for opening books or going to class, rewards may be very effective.

We must recognize that getting adults to begin and then go through a program is a problem. If they do they will learn. Such a finding, however, does not tell us anything about how learning takes place. We are always going through some kind of program, however poorly planned. We can say that programmed lessons can be quite efficient for learning some kinds of assignments, but going through programs only results in learning; we find out no more about the learning process by creating or analyzing programs than we can find out about the chemistry of bread by watching a baker create a loaf. He is also following a program—and may have no idea what is going on chemically.

The teacher may, of course, take the position that all he cares about is increasing the efficiency of learning. If that is the case, we can recommend that he try the programming approach. If the teacher wants to know more about what must go on for learning to take place and, perhaps, to develop maximal efficiency, he may want to look further and see what the psychology of learning has to offer.

Jerome Bruner, in his book, *Toward a Theory of Instruction*, also espouses the program/reward approach. He asks the teacher to be prepared and competent, and to know where he wants the student to emerge. Consequently, the teacher must have a structured plan covering some content, arranged in a proper stepwise procedure.

Bruner wants the student to be motivated, prepared, ready to learn. Bruner is a little short, however, on suggestions for achieving this state. Like Skinner, he relies on "reinforcement" or rewards to bring about the desired ends. The Bruner advice may puzzle the typical teacher, who must deal with five large classes in a day with little or no time even to observe, much less attend to, individual student problems or weaknesses.

The Skinner programmed learning operation might be implemented in classrooms despite numerous logistical problems, including the lack of good programs for all subject areas and ages. Teachers are obligated by a variety of parental and administrative pressures to pass students on from year to year, pretty much without regard to actual progress. Given the required social changes, the individualized techniques advocated by Skinner and Fred Keller might prove very effective for some purposes now served by the schools. But social changes in education only occur slowly, and we ought to make some progress without waiting for the day when each child is quietly working by himself in a cubicle provided with all the programs, computers, typewriters, etc., called for by some technologies of teaching. What might help in the meantime is some understanding by the teacher of what conditions foster learning and how learning takes place.

Learning and Behavior Control

We must recognize that a teacher, as Skinner so astutely observed, is a behavior controller, or at least he is charged with so being: "Order must be maintained." There are basically two ways to control behavior. Skinner's reasonably sound view is to reward people for doing what you want them to do. But there are some people who want neither your rewards nor to be rewarded at all. Some people resent rewards. Dale Carnegie won fortune and fame by advising people to let others reward them. To be popular and successful, "let people do you a favor," he said. Nice, if you can arrange it. The implication, however, is that people do not like those who do them favors and must like, admire, or want the approbation of those for whom they do favors. There may be some merit to this idea, although hard evidence is lacking.

Skinner recognized that most teachers are very unsystematic in giving rewards. Because of their many frustrations, they tend to adopt other techniques: threat and verbal abuse, deprivation, and various procedures that can be summed up as "aversive control." Such negatives generally cause students to dislike teachers and resist teacher efforts to guide them to some kind of academic success. For a variety of reasons, Skinner does not approve of aversive control. He advocates, primarily, a positive reinforcement approach.

We might start with the notion that the student/teacher relationship is a friendly or neutral one and that any emotional stress is probably of little help in a learning situation. We might want the teacher to be well liked, but that does not happen with all teachers. For some learning to take place, the teacher needs to generate positive reactions. What we can propose is that there is no point to the teacher's being deliberately cruel, brutal, and offensive—because the student may learn only that the teacher is cruel, brutal, and offensive.

The Educational Mystique

An important feature of education at all levels is the defensive role of the teacher, who feels he must maintain at all times the status difference between teacher and student. He must appear to know more than the student. Otherwise, how account for their separate roles? He knows the student is ignorant. He will, if the student is polite and suitably groveling, slowly let the student in on his secret knowledge. The history of this type of role playing probably begins earlier than the Egyptian priests and medicine men who carefully guarded the methods of their art, just as do modern day magician-entertainers who will never show you how their tricks are performed. Even if you guess, they will not admit you are correct.

Education is conducted on this basis: The teacher decides what the student is to learn. After all, he has the syllabus; the student does not. The teacher decides the examination questions; the student must try to guess what the questions will be. Some enlightened teachers provide a list of examination questions in advance. If the test is to include 100 multiple-choice items, the teacher might supply 200 or 500 items prior to the examination and indicate that any of them might appear on the test. Other teachers are horrified, in various degrees, at the very idea. What? Let the students know what is expected of them? They will obviously only learn the material that is presented and no more. Skinner had an easy retort to this argument: If you want students to learn more, give them 1,000 questions, or 5,000. Why should a student not know what he is expected to have learned?

Surprisingly enough, the motor vehicle bureaus of most states

whose duty it is to test potential drivers provide a booklet with questions that might be asked by an examiner. The booklet also gives the answers. Obviously, the bureaus know what they want drivers to know: the rules and regulations pertaining to driving. Even the Boy Scouts of America specify what the scout must know or be able to do to earn the various ranks and merit badges. The organization is following sound educational practices. But teachers hesitate; the examination should be a learning experience, they say. Why? Why not let the students learn before the examination? Why confuse the issues relating to testing?

Another common belief among teachers is that the examination should allow the student to integrate his knowledge. Why should a student have to integrate during an examination? Why not provide the integration, or make sure of it, before the test? Besides, how do you score integration? Is integration the function of some intellectual skill? If so, perhaps the student is not being tested for what he has learned but for something else that no teacher can provide (or test for adequately) in the first place.

The teacher should be prepared to tell his students precisely what is expected of them, with no ifs or buts. In arithmetic, for example, the student must know how to compute percentages or square roots or least common denominators. If he does not, he cannot be credited with a knowledge of arithmetic. There should be only one grade: 100% or "pass," where "pass" means that the student knows *all* that was expected of him. Such a position frightens or discourages teachers, because it means work for them. But there should be no real problem if the work is broken down into systematic and progressive units, as in the Keller stepwise arrangement. Before the student moves on to some new unit, he must demonstrate mastery of prior units underlying the new. To "pass" a student to a more difficult level of operations before he has mastered the simpler levels is sheer folly. He can only deteriorate progressively. Teachers often pass on the poor students they inherit and simply warn the next teacher about the poor prospects.

Estimation, Checking, and Modeling

A basic in education that is commonly ignored is the criterion of performance: the standard or acceptable answer. Granted the range of individual differences, some allowance may have to be made for students who are incapable of producing satisfactory performances or results; but a common fault in education is that students do not know a good result from a bad one. The minimal acceptable result must be displayed, demonstrated, or otherwise made clear.

The proposition holds for all fields, but we can illustrate from simple arithmetic. In that field, we can describe a correct answer to any problem in numerical terms. Suppose the answer to some question is $500. The students must know that the answer is in the neighborhood of $500 and not $50 or $5,000 or $50,000. Any operations that result in some number other than $500 are obviously incorrect. Some teachers will give "partial credit" for "method," but how can the method be correct if the answer is wrong? Credit for method is obviously a sop, a way of compensating a student for trying, but education is not designed to produce people who try; it is designed to produce people who learn.

What is lacking when students produce inferior results or wrong answers is an appreciation of what a good result looks like. To overcome this weakness, the student must learn to know when he is right. In arithmetic this is easy enough if a technique of checking each answer is learned along with the procedure. Checks should be required for every arithmetical operation. If a student determines a square root, he should now square the number and come out with the original number or an acceptable approximation. The degree to which an approximation is acceptable must itself be explicitly stated.

As a partial step toward more effective teaching, students should be required to estimate answers before engaging in any other mathematical procedures. Guessing games about the area of a room might be introduced with preliminary guesses about length and width. Some students are so concerned with numbers that they fail to take into account what the numbers are supposed to represent. There should be routine practice in estimation of such things as the length of a pencil, the number of pages in a book, the number of words on a page, the temperature, the outcome of a football game, a teacher's salary, the cost of automobiles, heights and weights, etc., until the units begin to mean something. In geography, questions about data concerning countries, states, cities, populations, etc., should be raised to encourage guessing, with subsequent checks. With a background of sizes, prices, times, etc., a student can be asked to look at a problem and guess the answer. Guided by a preliminary appraisal, he may be in position to question an answer obtained by a formal procedure and know if he is "in the ball park"—which itself could serve as a fine subject of estimates.

The Importance of Models

The procedure of estimating is only a suggested technique for the more important issue of correct models. Unless the student knows what someone else wants (and what he himself should want), he may stop with some answer or performance that is "pretty good" or "fairly close" or good enough to "get by." The student must be shown not only "pretty good" work but the results of master craftsmanship if he is to acquire appropriate standards. A cabinet made by an expert woodworker might be displayed as a model, with the fitting of the sides, the finish, etc., pointed out to serve as the standard. Drawings by Michelangelo might be exhibited as appropriate standards for art students instead of other students' work, although students should learn to evaluate a broad range of work. The student should be able to tell good work from poor and he should not be given an assignment until he can. On the college level, for example, a student in English writing might be required to write stories or essays in the style of acknowledged masters. While he might never write well, he might at least discover what style is.

This emphasis is based on the assumption that all work is guided by models, models in the form of imagery of the completed product or accomplished end. We used to speak of goals, but the psychology of "goals" has never been worked out to general satisfaction. Teachers have a way of describing goals in generalizations such as grades or success or satisfaction or "a well-rounded education." What is referred to here as a model is more specific imagery of the outcome of a specific task or sequence. A model of neatly tied shoes with equal length loops or a necktie tied so that the ends are even might illustrate the point. An artist's model might be a suitable

analogue: The artist tries to produce something on canvas or in clay that resembles, at least in many ways, some person, scene, or object. When the artist has no physical model, he can still try to "copy" his imagery of the subject. It is argued here that all learned behavior is similarly involved with a series of imaged models. Even listening to another person speaking involves our anticipation of his next words as we listen. Generally we can be correct in our anticipations, just as the reader commonly anticipates the next word or phrase as he reads.

The use of the model principle in education can be extended in a variety of ways. Students can be encouraged to make models of almost anything. The chemist makes models of water molecules with little balls and sticks. A sling-shot is a model of a catapult and illustrates a variety of principles of both physics and mathematics. A map, of course, is a model—of a neighborhood, a state, or the earth itself. Students who make a globe to represent the earth can it spinning on its own axis and around a model sun. A model of the tle of Gettysburg or Waterloo will demand the necessary learning as well as facilitate it. A three-dimensional model of the brain and spinal cord will teach more than books can illustrate or teachers can comfortably say. When events of real or imaginary history have to be learned, there is no better way to learn them than to relive them first in fantasy or imagery; then in dramatic form with characters, costumes, sets, action; and again in imagination. Students trying to learn a play should produce it—cast it, direct it, and criticize the interpretations of the actors.

Such learning via models takes time, but unless the lessons are trivial and not worth the time, it appears to be the only way to achieve lasting or effective learning. Of course, in the interest of saving time, one can skimp, substitute, and symbolize. One need not build 100 tepees to create an Indian village. A triangle drawn on paper can symbolize the entire village if only location is important. Available materials should be used if the construction feature is not relevant. A jig-saw puzzle map of the United States or Africa would be more helpful to many students of geography than simply looking at the map in a text. A game of "how fast can you assemble it?" can be played for five trials with time recorded per trial. The resulting graph itself can be instructive. The student will learn that it takes time to learn.

Learning Psychology and Education

Before we can even begin to talk about learning we must consider the learner. Is he in kindergarten, in primary or middle grades, junior high, senior high, college, a postgraduate institution, or not in school at all? Age and background are major variables and teachers must recognize them. A first-grade teacher with 20 years of experience is probably going to have trouble if suddenly assigned to teach second-graders. She does not know second-graders—what they can do, how they behave, how much they can absorb. These are questions that 20 years of experience with the first grade does not answer.

Our problem is like the search for the cure for cancer. There are hundreds of kinds of cancer, and the cure for one may be useless for another kind. There may never be a general prescription for cancer, and, similarly, there may never be a general prescription for learning that will fit all specimens of the human race. Not only do age groups differ in their abilities to learn, but individuals have different learning capacities at different times in their lives.

In this general account we are forced to ignore the issue of individual differences while keeping in mind that only individuals can learn. A "class" does not learn—it has no nervous system. The teacher must recognize that he is teaching individuals and not classes. As soon as the teacher adopts the class viewpoint, individuals who do not learn are regarded as obstacles of some kind and they are assessed as outlaws, incompetents, "learning disability" cases, "hyperactive." Or they are pinned with any other label that allows the teacher to rationalize their failure to learn. Tacitly or otherwise, teachers accept credit for their "bright" students. These they have taught. The poor performers have only themselves to blame. After all, the teacher taught the whole class!

Recognizing that teachers are going to continue teaching classes and not embark on private tutoring operations, we can now face the issues raised by and for the psychology of learning.

The Criterion Problem

In earlier days, when psychologists ran rats in mazes or asked students to memorize nonsense syllables, they established routines that differ widely from what teachers do in classrooms. They expected every rat or college student to learn to the same criterion—100%. The definition of 100% could vary, but, in the case of the rat, the psychologist kept putting the rat back in the maze until the animal went through the maze without an error. Similarly, the college student repeated *all* the syllables correctly once. Such criteria amounted to some specific level of achievement, met by everyone. No grades were assigned, even though some rats or students needed fewer trials than others. Note that the teacher, in such cases, knew what he wanted and worked until he got it. Some such standard should be required by *all* teachers. Any system of instruction that grades what the students can accomplish without imposing a minimal standard is open to the criticism that no teaching was done.

The Time Factor

If some standard of achievement is established as a first step, it is obvious that different students require different amounts of time, trials, instruction, or work in order to meet the standard. We can consider all of these differences as a function of learning time. It is now reasonably well established that different people need more or less time to learn one kind of assignment or another. To impose the same learning time (50-minute classes) on all students is to punish all those who need more or less time.

The national culture teaches us to expect instant satisfaction. With TV dinners and instant coffee, permanent press, and prebuilt almost everything, we have come to demand miracles in all fields, education among them. The national mania for sports has made idols of our skillful athletes and generated in children below as well as beyond the age of 40 the desire to be good at tennis, skiing, or ballet dancing almost instantly. The interest in tennis has developed a market in tennis rackets of various sizes and shapes in a range of prices that is almost staggering. Some 40-year-olds buy one racket after another in order to improve their game, refusing to recognize that top quality players are at the top because they started at the age of 4 or 5 with professional instructors and played for hours daily over a period of many years. A top Olympic champion swimmer began to swim at age 2 and spent almost as much time in the water as a fish.

Donald Norman, a professor at the University of California at San Diego, has reviewed the general question of how long it takes to learn something. The "something" is a skill or achievement like speaking your own or a foreign language, typing, performing surgery, possibly even something as apparently simple and routine as

cigar rolling. Norman's rough estimate is: 40 hours a week over a period of five years. After that much time you can be considered reasonably good at a complex skill like playing the piano. One should probably not regard anyone as a pianist who has not played about four hours a day for 10 years. The good ones have played more.

Educational problems arise out of paradoxes in a free, democratic society. No one in a democracy is "destined" to become any particular kind of professional, yet the parents of school children want them to be super-jacks-of-all-trades. While some children can be somewhat better than others at most things, none of them can be really effective at everything. One can excel, normally, only by putting in the necessary training time. In furthering excellence, teachers are hampered by institutional arrangements that require equal time for all children at all activities, and the time allotted is never sufficient to produce other than mediocre levels of achievement.

Several recent innovations indicate that the factor of time is being recognized as a major variable in learning. These innovations have been directed at individualizing learning activities. Some primary schools have adopted open classrooms where children work at tasks for as long as they choose; it is expected that, somehow, they will turn to other tasks when they have learned enough or gotten bored enough with their original choices. The open classroom is a cafeteria-like arrangement based on the assumption that children will select an appropriate educational diet. There is no substantial evidence to support the assumption. The Skinner-Keller self-paced programmed learning approach is another effort at individualizing learning. Students are free to work as long as they choose, at their own rates, to master units of work, one after another. The administrative problems in keeping track of the progress of the learners when each is doing his "own thing" are formidable and call for more staff than school boards are likely to make available. The effort to individualize learning, though laudable, also conflicts with parental desires that the children be prepared for anything and everything.

Our age is one of specialization; there is not enough time to learn everything, and decisions must be made about how the available time is to be spent. After all, what matters is not the time itself but what the learner does when he is in a learning situation. We must now look at the kinds of activities that result in effective or ineffective learning.

Recognition of the Role of the Learner

Increasingly since the decade of the fifties, psychologists probing learning and memory have come to observe what the learner is doing. The earlier tradition had generally endorsed the folklore that practice, i.e., repetition, was the basic learning principle. The teacher arranged conditions forcing learners to repeat, commonly by reciting in unison. The situation was reproduced in the laboratory. If a subject stared long enough at a memory drum presenting him with different nonsense syllables every two seconds or so, he would learn. In fact, many experimenters would caution the subjects not to "experiment" with different methods of learning—"just sit there and say them over to yourself as they appear" was the standard instruction. The learning would follow automatically. The procedure descended directly from Hermann Ebbinghaus, who in the late nineteenth century described his method of reading through a list over and over until he could recite it correctly. In a way, the standard laboratory procedure could be approved—it insured reasonably similar results from different laboratories. But in one laboratory after another it came to be recognized that not all the learners obeyed the standard instructions. They did "experiment" on their own, trying one method after another and finding one more useful than another. It began to appear that what the learner did was important.

The Recognition of Learning 'Strategies'

By the 1960s, what the learner did became the object of much of the research in learning laboratories, and new procedures began to be developed. In 1953, for example, Weston Ashmore Bousfield read a list of words to his subjects once and asked them to recall as much as they could in any order at all. In this one experiment he broke the traditional shackles that called for serial recall. He referred to his testing procedure as that of Free Recall. Once the subjects had responded as well as they could, Bousfield repeated the same words in a new order and tested again. After several such trials, Bousfield discovered that, despite the fact that the lists were randomized between trials, the subjects tended to report in a somewhat systematic fashion. Certain words would be reported in the same sequence from test to test, even though they appeared at different points in the reading. Such grouping was referred to as the "clustering" phenomenon. (Subjects manufactured their own order, each differing from the others.)

The procedure introduced by Bousfield resulted in a line of research that led to what Endel Tulving at the University of Toronto was to call "subjective organization." According to Tulving, the subjects were not passive recipients of knowledge. They were actively operating on the learning assignment, following various predispositions of their own based, presumably, on their own learning histories. Some subjects would merely recite to themselves as rapidly as possible, try-

ing to rehearse as many words as they could before the next words arrived. Others would first report the last few words they heard or saw while they were still fresh (an outcome that is attributed to "recency"). In any case, it became clear that the subjects were doing something other than simply sitting and looking or listening; they were trying to cope, each in his own way, with the material.

Incidental Learning

In the meantime, another type of learning research had been introduced, most prominently by Leo Postman at the University of California, Berkeley. Postman and his students arranged a situation where subjects would have to deal with material in some way (called "the orienting task") but without any instructions to learn. Other subjects in the experiment would be specifically instructed to learn the material. When the official learners were finished, the other subjects were also tested, even though they protested that they had not been asked to learn and did not try. Postman and his students, as well as hundreds of other researchers, discovered that instructions to learn, or intent to learn, were *not a necessary* condition for learning. The so-called "incidental" learners almost always learned something. They might learn very little in some cases, but in other instances could learn as much or more than those instructed to learn. It all depended on what they were asked to do. If they were told to count the letters in the words in some list, they would of course know how many letters there were but would not recall many words; if they were asked to think of synonyms for the words, they could recall many more.

In one of my own experiments, one group was asked to learn a list of 20 words in order, hearing them only once; another was asked to rate each word in the list for its imagery potential relative to the previous word, i.e., did the second word generate an image that could easily be associated with an image aroused by the first word? Note that the subjects were not told to learn anything—just rate the imagery value of successive pairs of words. A third group was asked to learn all 20 words by forming images of successive words in sequence. All subjects had the same working time (six seconds per word). At the end of the 120th second all subjects were asked to write down as many words as they could recall, either in sequence or out of sequence. The results appear below:

Words recalled

	Normal learning instructions	Imagery raters	Image learners
In sequence	6.63	9.52	11.49
Total recall	10.16	14.00	15.53

It is clear that those subjects who merely rated the pairs of successive words for imagery with no expectation of recall were far superior to those who tried to learn following their own inclinations. Those who used imagery intentionally were best of all.

Dozens of laboratory studies have produced similar findings. The instruction to use imagery is a most effective procedure for enhancing the learning of verbal materials. Why should this be so? It has long been known that "meaningful" material is learned more readily than "nonsense" material. Various procedures have been developed for assessing the meaningfulness of words, e.g., familiarity, frequency of usage, concreteness, and the number of associations prompted by specific words. When such ratings are high, the learning is easier than when the ratings are poor. If words are rated for imagery value, the learning shows the strongest relationship to the ratings. Apparently imagery has a potent relationship with meaningfulness. Alan Paivio, a professor at the University of Western Ontario, has made a strong case for identifying, if not equating, imagery with meaning. Why meaningful material should be learned easily may still remain as a question, but the answer may well be that when material is meaningful we are really making use of our past experience, our older learnings, and the new learning calls for less effort than when we have to become familiar with the new materials as such before we can make associations among them.

Processing

In the last decade, psychologists have begun to be attentive to the actions, behavior, or operations in which learners indulge when they are allegedly engaged in learning something. The word "allegedly" is used because while many try to learn, not all succeed uniformly.

We have already alluded to individual differences where the factors operating might be hereditary or functions of age or stage of development. Now we are concerned with precisely what the learner is doing.

Every teacher has encountered the situation where the student with a low grade on a test says, "But I read the assignment three times!" The unwise teacher says, "Go read it again." Such advice is probably of little merit, as the likelihood of future profit from a procedure that has failed in the past is indeed dubious. Those who performed better on the test may not have read the assignment as often, so better advice might be, "Go do what the better students did *instead of* reading three times."

The issue is quite clear. Different people approach a learning task not only with different backgrounds of content and prior knowledge, they use different task techniques. Some students, starting with the first paragraph of an assignment, underline what they regard as important sentences. The chapter soon becomes a blaze of color, if the student favors a colored marking device. The impracticality of such a practice should be self-evident: How can the important material be recognized before the entire content is appreciated? Other students may outline the chapter in notes. Again, this may appear sensible, but the outline cannot be appreciated prior to an acquaintance with the content.

An alternative that appears more suitable is to skim the chapter first, attending particularly to the conclusions and to the author's own indication of what is important. An even better way might be for the teacher to provide the outline and let the student *look for* the related supporting material or answers to questions in the outline. The usual workbook accompanying texts is in fact a good learning device, when the student uses it appropriately. Workbooks provide blank spaces to be filled with relevant material from the text. The student has to write or create part of a chapter or paragraph. To do this he must find the desired material by inquiry or search. Such an active operation has been generally supported since research in the psychology of learning began. Early in the century Arthur I. Gates demonstrated that, with such a task as learning a list of words, reading the list over and over was a relatively poor procedure. Experiments showed that active rehearsal, i.e., trying to recall the list instead of merely reading it, was much more effective. In fact, a read-

ing time of 10% and a rehearsal or reconstruction time of 90% proved to be the optimum ratio.

What works for a list of words may not be ideal for other tasks, but it seems obvious that students should be advised to think, rehearse, and anticipate rather than simply read. Better yet, advise a student to put himself in the position of the author of the text faced with the prospect of writing the assigned material or chapter. The student could attempt a possible outline for the chapter. What topics or points would have to be covered? What does the student know now? What kinds of information would he or other students want to know? The student's outline and that of the author might not agree to any great degree, but the comparison might be challenging and fruitful. The student would be engaged in asking questions about the prospective reading, and such a process has been shown to be a very effective procedure for gaining information from texts. (See Eleanor Gibson and Harry Levin, *The Psychology of Reading.*)

In recent years the practice of asking older students to help teach younger or less well-prepared students has been growing apace. Presumably this operation has its roots in the discovery by all teachers that they never really "knew the stuff" before they tried to teach it. Once the responsibility for teaching has been accepted, the teacher begins seriously to learn. There is no mystery here. The intent to teach is no more important than the intent to learn. What is important is that the teacher-to-be begins to put in the necessary time to organize, to program, to check the facts, to tie the loose ends. The new teacher learns more than the new student because he works harder and longer at the job. The trick of teaching is to make all students teachers.

The practical aspects of making all students teach may well be prohibitive or awkward and difficult. This procedure is readily used, however, in written assignments. The student can be made responsible for some reasonable part of a study exercise that can be dittoed or otherwise copied for an entire class. The class can thus prepare a textbook with mutual questioning, criticism, and supervision by the teacher.

The major point to be recognized is that it is the inquiring and constructive attitude that is the base for learning; without it there will be no true processing of the material. Students must first be taught to look for answers in books, not read the books in a passive

manner, hoping that something will stick. If a book has an index, the reader should study that first and look up topics. If the book has a table of contents, that too should be studied with an inquiring attitude. A student should ask himself, "What will be said in this chapter or section?"

Processing for Meaning

All that has been stated above amounts to asserting that unless the material under study is worked over in a creative, constructive way, very little will be learned or retained. The principle under consideration is that of learning as contrasted with teaching. There is no such operation as teaching in and of itself. No one can teach anyone anything; he can only arrange conditions whereby a learner might learn. Among such conditions are showing and telling, but whether or not learning goes on depends more on the learner than the teacher.

The very term teacher is probably a meaningless label. A better name is educator. The educator "draws out" the learner or leads him out of ignorance, but it is the learner who must take the steps for himself. He must go through a process of creation of knowledge. What teachers can do is to save the learner time by preventing errors or movement along blind alleys. In learning algebra or geometry, for example, a student must, in effect, discover the principles for himself if he is ever to master the subject. Being told what to do cannot work except for a short time and/or a specific problem. If a formula is forgotten, the student who merely memorized it is lost. If, instead, he derived the formula, he can do it again. Of course, if he learned that he can "look it up," then he has learned to that level; but if the issue is the nature of learning, then we must recognize the necessity of construction.

The construction involved in learning includes the recognition of a problem and the attempt to solve it in imagination. Suppose a teacher is trying to impress students with the simple beauty, sincerity, and import of Lincoln's Gettysburg Address. The students could be asked to imagine themselves as Presidents of the United States with a duty to deliver a speech at the dedication of a cemetery for fallen soldiers. They can then be told to write the speech they would deliver. A later comparison of their own efforts with the Lincoln mas-

terpiece should prove revealing and educational. Delivering the speech without notes might also be valuable.

Meaning and Memory

All that has been said earlier points to the conclusion that if we are to learn and if we are to remember, the material involved must be made meaningful. It has been stated that the learner must imagine situations, problems, and procedures for solution if material is to be meaningful to him. Such imagery is at the heart of the matter, whether the subject be historical, literary, scientific, or mathematical. Students must be trained to image situations. If the imagery can be checked with physical models, so much the better; but the images are the only tools we have to work with, granted that some symbols might be otherwise employed as part of our problem-solving efforts.

Remembering

Once something has been learned to some criterion level, there is no guarantee that it will be remembered later. "Later" lasts from a few seconds till the end of the learner's life, of course. Most things one learns are learned to a modest level and will be quickly forgotten. It is generally agreed that we forget for only one reason: namely, interference with other learnings. The interference can come from what we have learned before (proactive inhibition) or what we learn later (retroactive inhibition). Because we are continually learning new material, we are also going to forget a great deal.

It is of vital importance for students and teachers to recognize the inevitability of forgetting. Students should learn early that 1) there is no such thing as a poor memory (a convenient excuse for parents and other authorities), and 2) things are either learned well or poorly. Because everyone necessarily forgets, it becomes important to come to terms with this reality.

Ways of Coping with Forgetting

If we consider something important enough to want to remember, there is only one option: Learn it well and keep rehearsing it as often as necessary. This means systematic review of all important information. As the reviews are repeated, they will take less and less time, a finding of Hermann Ebbinghaus in 1885. Ebbinghaus called this the Savings Score and used it to measure the amount of retention/forgetting compared to original learning effort. The learner should know that he can always relearn something in less time than it took originally; but because he is likely to forget, he should not let too much time pass (with its attendant new learnings) before he reviews. A cram session before examinations is really a relearning experience. There is nothing wrong with cram sessions, except for the usual delay until just before some test. If a series of cram sessions is spread out over a semester, we call it "reviewing" and find it efficient in that it saves relearning time. A lot of anxiety is eliminated by frequent reviews, because the learner gains confidence in his ability to relearn and also discovers that it does not take too long with each succeeding review.

Another useful device for remembering specific information is to go to the trouble of "tagging" it, i.e., to recognize that there may be a problem of retention and to ask oneself: How will I remember this? The problem is similar to that of locating your car in a crowded parking lot. If you realize that you may have a problem in finding your car, you can look for landmarks, even write them down, and then feel quite secure as you leave. If you merely leave the car without bother-

ing to notice appropriate cues, you may have trouble later. Similarly for any other learning content. How will you remember this formula, these laws, these numbers, or whatever? Knowing that you will forget, you can take the necessary extra time to learn an appropriate cue or tag.

Such tagging is common practice with professional mnemonists, who deliberately tie the new information to some specific prelearned pegs or features of a situation that will inevitably arouse the necessary recall. One need not be a professional mnemonist, however, to make a deliberate effort to seek out appropriate cues. To remember that Henry Clay was the Great Compromiser, one might simply take the first letter of Clay and compromise as the recall tags. It might help to remember Harrisburg as the capital of Pennsylvania if one took the trouble to find out who Harris was. It all sounds like work, but that is the whole point. Without some work, there will be no retention. If you go to the trouble of finding out why the capital of Washington was named Olympia you are unlikely to forget it.

Differentiation

Implied in the above treatment of tagging is the notion of differentiation. Barring identical twins and machine-made articles, there are no two things alike. Much of our trouble in learning and remembering is that we do not pay enough attention to the differences that exist among people, events, chemical formulas, etc. It is by now a truism of learning psychology that the basic step in learning for future recall is to notice the specific aspects of the materials one is asked to learn/remember and to scrutinize them for any potential trouble-making similarities to other already known items.

If we pay only lip service to items, we will not remember a great deal. Most people, for example, do not recognize a particular rose when they see it. They may even pass it off as "a flower." But there are thousands of roses, each with its own characteristics, ancestry, and name. To tell one from another one must notice at least whether it is a cultivated or wild rose, a tea rose or a floribunda, a climber or a pillar. He must check leaf color, bud shape, petal count, leaf and bark texture, etc. The more work done on the problem, the more completely one rose is *isolated* or *differentiated* from the others.

The italicized terms above are crucial in describing what must occur for learning to take place. The learner must discriminate each item to be learned from all potential competitors. This feature of learning is least respected by inexperienced or inefficient learners; they learn one thing at a time and add to their knowledge by successive increments without clearly establishing the important differentiating factors as they go. The result will be a jumble that prevents or interferes with later learning and recall.

The issue is readily illustrated by the difficulties we have in learning people's names. Fortunately we are not all named Smith. The Smiths themselves make every conceivable effort to differentiate by the way they spell the name. The P. G. Wodehouse hero, Psmith, is perhaps an extreme example, but one probably could not forget him once he spelled his name for you and told you the P was silent, as he usually took pains to do.

Summary

The psychology of learning applied to education does not provide any panaceas to solve the problems of teachers. What appears to be the message is that learning is work and takes time, a lot more time than most of us are willing to devote to the matter. It is impossible to teach anyone, but it is not impossible for anyone to learn if he puts in enough time effectively. Children who spend their time watching television do not learn to read. Even if they do not watch television, they will not learn to read if they have no books or reading matter and do not work with such materials. Children who have pocket-size calculators around will not learn arithmetic either; they may learn to operate the calculators if they work with them, however. In any case, there is no prospect of any serious learning if a learner does not have a conception (model) of what he is supposed to know or do and if he does not care to bring this conception to fruition. The teacher's job is to supply material, propose the appropriate models, save the student the trouble of avoiding the common mistakes that mankind has floundered through over the centuries, and point out the common errors, all the while emphasizing the discriminative features of potential confusers.

In 1976 the president of the American Psychological Association, Wilbert J. McKeachie, reviewed the problem of applying learning psychology to education. His basic plea was to spend less on bombers and more on multiplying the number of teachers. The number of teachers is a crucial point; with more teachers all of the suggestions included in this fastback might be more effectively implemented. In

his review, McKeachie made some other proposals that might be of benefit. He advocated *small* classes and *small* schools and, as advocated here, the teaching of learning strategies.

Two of McKeachie's suggestions are apt statements with which to conclude this effort:

1. I would emphasize the importance for student learning of talking, writing, doing, interacting, and teaching others.

2. I would call attention to the importance of teachers as models for students.

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